# Trade Liberalisation, Prices and the Skill Premium in South Africa

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In partial fulfilment of the Masters Degree in Economics at the University of Cape Town

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15 February 2011



**Abstract**

We look at how trade liberalisation, working through product prices, has affected the skill premium in South Africa over the period 1990-2009. Our main finding is that trade liberalisation lead to a reduction in prices over this period, and through prices mandated a rise in the skill premium of 3.3%. The structure of the skill premium did not stay constant over the period. In the sub-period 1990-1999, trade liberalisation mandated a fall in the skill premium of 10.6% and in the other sub-period 2000-2009, trade liberalisation mandated a rise in the skill premium of 11.6%. Our main results are consistent with the sector bias of tariff cuts over these periods, however they do not pass some of the robustness checks that we perform.

[1] I am very grateful to the Trade and Industrial Policy Strategies (TIPS), Southern Africa Labour and Development Research Unit (SALDRU) and the National Research Foundation (NRF) for financial support during the course of my masters studies. Views expressed in the paper should not be taken to reflect those of the above institutions.

# Contents

## 1. Introduction

Both nominal tariffs and effective rates of protection have generally been falling in South Africa since 1994. We interpret this fall in tariffs and effective rates of protection as evidence for increased trade liberalisation in South Africa. We then investigate the impact of this trade openness on the skill premium[2] in the South African manufacturing industry over the period 1990-2009. We conduct our study within the Heckscher-Ohlin (HO) framework. The HO theory's prediction for developing countries is that relative price increases due to trade liberalisation will be concentrated in unskill-intensive sectors. The Stolper-Samuelson (SS) theorem then predicts that such relative price increases will increase relative returns to unskilled workers thus reducing wage inequality.

Many studies that have empirically looked at the impact of trade openness on wage inequality in developing countries have often done so using the factor content approach or labor usage equations. These studies cannot be interpreted as applying the HO and SS theory on the data. In South Africa, we are only aware of two studies that have done empirical work on trade and wages within the HO and SS framework. Fedderke et al. (2003) use manufacturing data over the period 1972-1997, Edwards and Behar (2005) use firm level data over the period 1994-2003. One central premise of the methodology used in these studies is that it builds on zero-profit conditions to obtain mandated wage equations. These equations relate changes in product prices and technology with changes in factor prices, which is in line with the SS theorem.

We contribute to this literature by looking at the South African SIC three digit level dataset that extends to 2009. One practical concern with the empirical application of the HO and SS theory is that it predicts a long run relation. The theory is however silent on the timing over which the long-run equilibrium is likely to hold. Mandated factor returns may not be constant overtime such that product price changes favor unskilled labor in some periods and skilled labor in others. These changes can be missed if one adopts a very long time period as long run. We address this issue by further breaking the 1990-2009 period into two sub-periods: 1990-1999 and 2000-2009.

In taking the theory to the data we first investigate the sector bias of trade barrier cuts and hence price increases. This is achieved by regressing trade barrier changes on factor cost shares. Given

[2] We define the skill premium as the relative wages of skilled to unskilled labor. So the terms skilled premium and wage inequality are used interchangeably.

that trade barriers have generally been falling and assuming a uniform pass-through coefficient from tariff barriers to product prices, a larger coefficient on the skilled (unskilled) labor cost share indicates that trade barrier cuts are concentrated in unskill (skill)-intensive sectors. This provides suggestive evidence for a rise (fall) in the skill premium. In order to estimate changes in the skill premium caused by trade liberalisation we adopt the two-stage procedure of Feenstra and Hanson (1999). In the first stage we regress product price changes on tariff changes and a set of other structural regressors. This enables us to calculate the portion of product price changes attributable to tariffs. In the second stage we regress this trade barrier induced changes in product prices on factor cost shares. This gives factor price changes mandated by trade barrier cuts working through product prices.

Our main finding is that tariff cuts are biased towards unskill-intensive sectors in the periods 1990-2009 and 2000-2009, suggesting a rise in the skill premium. In the period 1990-1999 tariff cuts are concentrated in skill-intensive sectors suggesting a fall in the skill premium. Over the period 1990-2009, tariff reductions lead to a fall in product prices, and through prices mandated a rise in the skill premium of 3.3%. Between 1990 and 1999, the mandated skill premium fell by 10.6% and over the period 2000-2009, tariff reductions mandated a rise in the skill premium of 11.6%. Therefore, our results are consistent with the sector bias of tariff reductions. Our main results are estimated with SIC three digit fixed effects and weighted using real sales. Adding time fixed effects does not substantially change our main results and unweighted results are very similar to weighted results. Our main results are however not robust to the use of effective rate of protection as a measure of openness. In addition, they are not robust to the use of value added prices as a regresand in the first stage equation.



The remainder of the paper is organized as follows: Section 2 reviews theoretical mechanisms that provide links from trade openness to wage inequality in developing economies, section 3 reviews previous empirical evidence and section 4 presents the mandated wage methodology. Section 5 gives econometric specifications, section 6 describes the data and discusses the behaviour of prices trade barriers in the South African manufacturing industry. Section 7 describes the results, section 8 tests the main results for robustness and section 9 concludes.

## 2. Theoretical Mechanisms

The analytical framework most commonly used to explain the distributional consequences of trade liberalisation is the Heckscher-Ohlin model. In its simplest form the model assumes: two countries (developed and developing), two factors (skilled and unskilled labor), and two goods (skilled-intensive machinery and unskilled-intensive clothing). The developing country is relatively more abundant in unskilled labor while the developed country is more abundant in skilled labor[3]. Because of relative abundance the relative price of unskilled labor will be lower in the developing country. Therefore the developing country will have a comparative advantage in unskilled-intensive clothing.

In the absence of trade clothing's price will be lower in the developing country, the opposite applies to machinery. Trade liberalisation will thus raise the price of clothing and lower the price of machinery in the developing country. The link between such product price changes and factor price changes is provided by the Stolper-Samuelson theorem. According to the SS theorem an increase in the relative price of a good will increase returns to the factor used intensively in the production of that good and reduce returns to the other factor. Combining the Heckscher-Ohlin and Stolper-Samuelson (HOSS) results imply that trade liberalisation increases relative returns to unskilled workers thus reducing wage inequality in developing countries.

Predictions of the HOSS theory have been shown to fail empirically, particularly in relation to developing countries. Extensive empirical studies have found an increase in wage inequality following trade liberalisation in many developing countries[4], for example (Wood 1997, Vivareli 2007).

Davis (1996) develops a simple theoretical model that makes sense of the anomaly faced by the HOSS theory. In the model he keeps many assumptions of the HO theory, including that of identical technology across countries. The model's central departure from conventional theory is to assume that relative endowment differences in the world are too large to allow for factor price equalization. Acceptance of this premise necessitates a radical revision in the conventional way of interpreting the HOSS result. Relative factor abundance of a country still drives HOSS predictions of trade

[3] Other assumptions are perfectly competitive markets, identical tastes and technologies across countries
[4] We use the phrase developing countries to mean middle and low income countries, and developed to mean high income countries.

liberalisation. But factor abundance should not be assessed in relation to the world as a whole. Instead it should be measured only relative to a group of countries that have similar endowment proportions and produce the same range of goods. These countries are said to constitute a 'cone of diversification'. A developing country can be unskilled labor abundant in a global sense. But if it is skilled labor abundant relative to its own cone, then trade liberalisation will raise wage inequality. This is precisely the opposite of what one would anticipate with a more conventional interpretation of the Stolper-Samuelson theorem.

Feenstra and Hanson (1996, 1997) develop a model of trade in intermediate inputs whose predictions are also in contrast with HOSS predictions. In the model there are two countries (developed and developing), developed is skilled labor abundant while developing is unskilled labor abundant. There is a single final good which requires a continuum of intermediate inputs with different levels of skill intensity. The inputs can be produced in either country, once produced they are costlessly assembled into the production of a final good. Firms doing the assembly source their inputs from the minimum cost location. In equilibrium each country produces the range of goods for which they have minimum cost. The relative wage of unskilled labor is lower in the developing country. Therefore, with trade liberalisation the developed country will outsource some low skill-intensive intermediate inputs from the developing country. While such products are less skilled-intensive from a developed country's perspective, they are more skilled-intensive than any inputs previously produced in the developing country. This has the effect of lowering the relative demand for unskilled labor thus raising wage inequality in both countries.



Zhu and Trefler (2003) extend Feenstra and Hanson's model to a case with a Ricardian source of comparative advantage added to that of factor endowments. In their model technological catch up by the developing region causes production of the least skill-intensive goods to migrate from the developed to the developing region where they become the most skill-intensive goods. Thus average skill intensity rises, increasing demand for skilled labor and hence wage inequality in both regions.

Pissarides (1997) develops a model in which developing economies advance by learning from the technology of developed economies. In the model trade liberalisation in the developing economy leads to more technology transfer from developed to developing economy. The central assumption is that the transfer technology is skill biased. It is shown that the relative demand for skilled labor increases during the transition following trade liberalisation, thus causing a temporary increase in wage inequality in the developing economy. If the transferred technology is also skilled biased then the wage inequality increase becomes longer lasting.

HO theory assumes perfect factor mobility implying that the impact of trade on wages is the same across sectors. Therefore it does not account for the existence of inter-industry wage differentials for similar workers. If some factors are not perfectly mobile, then we must adopt a model which accounts for this. One such model is the specific-factor model. In the model there are three factors, one is perfectly mobile while the other two are each specific to a particular sector. The general outcome of the model is that trade liberalisation benefits the export specific sector, hurts the import competing sector, with ambiguous effects on the mobile factor. The distributional consequences of trade liberalisation will then depend on which factors are specific to which industries. If unskilled is specific to the export sector and skilled is specific to the import competing sector then the model generates a fall in the skill premium, otherwise it generates a rise in the skill premium. However if factor immobility is within skill groups then the model generates ambiguous effects of trade on the skill premium, instead it allows for inter-industry premiums.

The theoretical evidence reviewed here suggests that, a priori, there is no strong reason to expect wage inequality in developing countries to move in a particular direction following trade liberalisation. The impact of trade liberalisation on the skill premium can be better resolved empirically. This evidence also highlights the importance of controlling for technology in ascertaining the impact of trade on wage inequality in developing countries. This is because technological progress in developing countries is an endogenous outcome of openness, and affects wage inequality at the same time.



## 3. Previous Empirical Evidence

Slaughter (1998) reviews nine empirical studies that investigate the link between trade liberalisation and wage inequality in the US. Results emanating from these studies are mixed: Some do not find a strong link between trade and wage inequality, others conclude that trade has contributed to the rising US skill premium. Slaughter concludes that these results are sensitive to the selection and weighting of industries and to the time period. In addition, he points out that these studies do not directly link changes in product prices to some measure of international trade.

Feenstra and Hanson (1998) argue that the price regression used in the previous studies reduces to an identity when fully specified, therefore it does not provide new information about the contribution of international trade to wage inequality. They use a two-step estimation procedure to overcome this limitation, they then apply this procedure to the US data. In their study they measure trade by the foreign outsourcing of intermediate inputs. They find a significant contribution of trade to rising US inequality in the 1980s. In contrast, Slaughter and Haskel (2000), using the same methodology, do not find a significant contribution of international trade to US wage inequality in both the 1970s and 1980s. The latter use falling tariffs and transportation costs to measure trade liberalisation.

Most developing country studies have documented rising wage inequality following trade openness. But the causal link is not directly from trade to wage inequality. It is rather skill biased technology adoption, by developing countries, that is documented to have increased wage inequality in many developing countries. Wood (1997) attributes the rise in wage inequality in Latin America since the mid-1980s to "new technology biased against unskilled workers". Using a sample of 20 developing countries Zhu and Trefler (2003), provide empirical evidence to support the view that technological catch up by developing countries increases wage inequality in developing countries. Meschi and Vivarelli (2007) find a weak link between total aggregate trade flows and wage inequality in a sample of 70 developing countries. However, once they disaggregate trade flows by their country of origin/destination, they find that trade with high income countries worsens inequality in middle income countries (MIC) but not in low income countries (LIC). They interpret their results as supportive evidence for the view that MIC have greater potential to absorb new technology compared to LIC.



Fiandero and Rankin (2008) use Mincerian earnings to investigate the relationship between trade openness and industry premiums in South African manufacturing. They find that an identical individual in a low tariff sector earns more than one in a high tariff sector. Shendy (2007) also look at trade openness and industry wage differentials. They find that the impact of tariff cuts on industry wage differentials depends on the level of union power. Tariffs cuts decreased wages of workers in industries with higher union power compared to similar workers in industries with lower union power. These studies do not address the impact of trade openness on the skill premium. Fedderke and Vaze (2003) and Edwards and Behar (2005) address this issue using the mandated wage methodology. The former find that trade decreased returns to unskilled relative to skilled labor in

South Africa over the period 1972-1997. The latter also find that trade decreased real returns to unskilled relative to skilled workers in South Africa over the period 1994-2003[5].

## 4. Methodology

The empirical strategy of this paper is based on the production side of the Heckscher-Ohlin theory for a single country. The model economy is characterised by many industries of different skill intensity and perfect factor mobility across industries. With perfect competition in the economy, factor prices adjust to any shock to aggregate relative labor demand to ensure zero profits in all sectors.

Formally, suppose the economy produces N different tradable goods, each good requires J primary factors and N intermediate inputs. The economy's entire set of zero profit conditions can be written as:

$$\mathbf{P} = \mathbf{AW} + \mathbf{BP} \qquad (\mathbf{1})$$

where **P** is an (Nx1) vector of domestic gross-product prices, **W** is a (Jx1) vector of domestic factor prices, **A** is an (NxJ) primary input requirements matrix whose $a_{nj}$ element gives the number of units of primary factor j required to produce one unit of product n, and **B** is an (NxN) matrix of intermediate input requirements whose $b_{nn}$ element gives the number of units of intermediate input n required to produce one unit of product n[6].

There are three points worth noting about (1). First, there are N equations in (1), one for each sector where production occurs. Second, in the special case of a small open economy **P** is also the world price vector. Third, because the HO framework assumes perfect factor mobility across sectors, wages **W** are not indexed by sector n.

Equation 1 simplifies to:

$$\mathbf{P^V} = \mathbf{AW} \qquad (\mathbf{2})$$

where $\mathbf{P^V} = \mathbf{P} - \mathbf{BP}$ is a set of value added prices. Totally differentiating (2) gives:

[5] This paper has four worker categories: managers and professionals, skilled and artisan semi-skilled and unskilled. It reports a fall in relative returns of each of the three categories relative to unskilled labor.
[6] n = 1, 2, . . . . . . . . . , N

$$\mathbf{P}^{\mathbf{V}*} + \mathbf{TFP}^{*} = \mathbf{VW}^{*} \qquad (\mathbf{3})$$

where **V** is an (NxJ) initial cost share matrix whose $V_{nj}$ entry gives the share of factor j in the average cost incurred to produce one unit of product n. $\mathbf{P}^{\mathbf{V}*}$ and **TFP*** are vectors of changes in value added prices and technology respectively, and $\mathbf{W}^{*}$ is a vector of economy-wide factor price changes. Equation (3) shows how economy-wide factor prices ($\Delta \ln w_j$) adjust to changes in product prices ($\Delta \ln P^{V}{}_{n}$) or technology ($\Delta \ln TFP_n$) to restore zero profits in all sectors. In (3) the wage effects of price changes depend on their sector bias. Price increases in a sector tend to increase relative wages of factors employed more intensively in that sector. This sector bias intuition linking product prices and wages is the thrust of the Stolper-Samuelson theorem.

Estimating (3) as a linear regression across industries overtime requires data on: change in value added prices, change in technology and factor cost shares. The estimated regression coefficients give mandated factor price changes. These are factor price changes required to maintain zero profit conditions in the face of changes in product prices. Many product price studies have tried to ascertain the impact of trade on wage inequality by estimating various specifications of equation (3). Feentra (2004) show that equation 3, when fully specified reduces to an identity. This means that estimating equation 3 does not provide us with any new information about the impact of trade on wages.

To make further progress Feenstra and Hanson (1999) propose a two-stage approach. In the first-stage they regress price changes on a set of structural regressors, $Z_m$, which are assumed to drive price changes over some period:

$$\Delta \ln P^{v}_{nt} = \sum_{m=1}^{M} \delta_{mt} Z_{mnt} + \acute{\varepsilon}_{nt} \qquad (\mathbf{4.1})$$

where $\acute{\varepsilon}$ is a random error process. An alternative specification of 4.1 is to use the gross price series as a regressand instead of value added price:

$$\Delta \ln P_{nt} = \sum_{m=1}^{M} \delta_{mt} Z_{mnt} + \beta \sum_{n=1}^{N} b_{nnt} \Delta \ln P_{nt} + \acute{\varepsilon}_{nt} \qquad (\mathbf{4.2})$$

The second- stage is a regression of the contribution of each structural variable $\hat{\delta}_{mt}\Delta Z_{mnt}$ to price changes, on factor cost shares:

$$\hat{\delta}_{mt}\Delta Z_{mnt} = \sum_{j=1}^{J} V_{jnt}\,\zeta_{jmt} + \acute{\varepsilon}_{nt} \qquad (\mathbf{5})$$

The m[th] coefficient $\zeta_{jmt}$ is interpreted as the portion of the total change in the j[th] factor price that is explained by the m[th] structural variable. For example, including tariff changes in (4.2) determines the amount of product price variation accounted for by tariff changes. Using that amount as a regressand in (5) gives the wage changes mandated by the sector bias of tariff changes working through product prices. Comparing these with actual factor price changes gives contribution of tariff changes to overall factor price changes.

In order to investigate the sector bias of tariff changes we regress tariff changes $\Delta\ln(1 + TAR_{nt})$ on factor cost-shares($V_{jnt}$):

$$\Delta\ln(1 + TAR_{nt}) = \sum_{j=1}^{J} V_{jnt}\,\gamma_{jt} + \acute{\varepsilon}_{nt} \qquad (\mathbf{6})$$

The coefficients in (6) describe the sector bias of tariff changes. If tariffs are generally falling and assuming a uniform pass – through rate from tariff changes to product price changes. Then larger (smaller) coefficients on the skilled-labor cost share than on the unskilled-labor cost share indicate that tariff cuts are concentrated in the unskill-intensive (skill-intensive) sectors. This provides suggestive evidence for a rise (fall) in the skill premium.

## 5. Econometric Specifications

Equations 4 to 6 are the equations of interest. Their estimation requires product price data, tariffs, factor cost-shares, input requirements and a set of structural factors which include total factor productivity, US product price and capital-labor ratio.

Given the long-run nature of the HO framework, we estimate mandated wage regressions over long periods. Initially we consider the entire period from 1990-2009. We then investigate whether the behavior of the skill premium has changed or stayed the same over the period. This is achieved by breaking the entire period into two sub-periods: 1990-1999 and 2000-2009.

We consider three specifications of the first-stage regression (4.1/4.2), each with different sets of structural forces based on different price-setting assumptions about the SA economy. Initially we give SA the status of a small open economy. If we assume perfect competition in the domestic economy and constant international prices then domestic product price changes will only come from changes in trade barriers. Therefore, we estimate the following equation by including only tariffs as a structural regressor in (4.2).

$$\Delta \mathrm{lnP_{nt}} = \delta_1 \Delta \ln(1 + \mathrm{TAR_{nt}}) + \beta \sum_{n=1}^{N} \mathrm{b_{nnt}}\, \Delta \mathrm{lnP_{nt}} + \acute{\varepsilon}_{nt} \qquad (\mathbf{4.2a})$$

Our second specification introduces two changes to (4.2a). First it allows US technological change to affect domestic technology and hence product prices. One possible mechanism is the one advanced by Pissarides (1997) in which developing countries advance their technology by learning the technology of more developed countries. Second it allows world demand and supply factors to affect domestic prices. Ideally, we would use changes in world product prices to proxy for world demand and supply factors. The idea is that world demand and supply factors are communicated to domestic prices via world prices. However, we do not have data on three-digit changes in world product prices. So we proxy for the world PPI using the US producer price index. This gives

$$\Delta \mathrm{lnP_{nt}} = \delta_1 \Delta \ln(1 + \mathrm{TAR_{nt}}) + \beta \sum_{n=1}^{N} \mathrm{b_{nnt}}\, \Delta \mathrm{lnP_{nt}} + \delta_2 \Delta \ln \mathrm{TFP_{nt}} + \delta_3 \Delta \ln \mathrm{USPPI_{nt}} + \acute{\varepsilon}_{nt} \qquad (\mathbf{4.2b})$$

Our third specification allows the pass-through coefficient from tariffs to product prices to depend on market structure. Ideally, we would use industry concentration ratios as a measure of market structure. However, we do not have data on industry concentration ratios. Therefore, we use capital-labor ratios to measure market structure. The idea is that less-competitive industries (those with higher capita-labor ratios) may show less pass-through from trade barriers to domestic prices, Haskel and Slaughter (2000). This gives

$$\Delta \ln P_{nt} = \delta_1 \Delta TAR_{nt} + \beta \sum_{n=1}^{N} b_{nnt} \Delta \ln P_{nt} + \delta_2 \Delta TFP_{nt} + \delta_3 \Delta USPPI_{nt} + \delta_4 \left( \Delta TAR_{nt} \times \left( \frac{K}{L} \right)_{nt} \right) + \acute{\varepsilon}_{nt} \qquad \mathbf{(4.2c)}$$

where $\Delta TAR_{nt} \equiv \Delta \ln(1 + TAR_{nt})$. Equations 4.2a – 4.2c are all first stage regressions. For every period, each gives rise to three second-stage regressions. In the second-stage, we regress the amount of product price variation due to tariffs on factor cost shares. This gives

$$\hat{\delta_1} \,\Delta\, (1 + TAR_{nt}) = \zeta_S V_{Snt} + \zeta_U V_{Unt} + \zeta_K V_{Knt} + \zeta_I V_{Int} + \mathcal{E}_{nt}$$

The coefficients $\zeta_S$, $\zeta_U$, $\zeta_K$, and $\zeta_I$ give mandated changes in skill, unskill, capital and intermediate factor returns required to maintain zero profit conditions in the face of tariff-induced price changes.

## 6. Data

### 6.1 Construction and Sources

The data used covers 40 SIC three–digit SA manufacturing sectors over the period 1990 – 2009. Domestic product price data (PPI) was obtained from the Department of Trade and Industry. We use the PPI data together with intermediate inputs cost shares to construct the value added price data. Intermediate input cost shares were calculated from the 2002 Supply–Use tables, Supply - Use tables were obtained from Statistics South Africa. The Supply–Use tables data is more disaggregated than the product price data, we aggregate it to match up with the SIC three–digit level product price data.

We define capital labor ratio (K/L) as the stock of machinery and equipment capital per employment. Capital stock data was obtained from Quantec and employment data was obtained from the Department of Trade and Industry. We use real sales to weight our observations. The

USPPI data was obtained from the US Bureau of Labor Statistics. The data up to 2003 is based on the old US classification (SIC). This has been discontinued and replaced by NAICS. In updating the data we link NAICS industries to the closest match in the SIC classification. We then map US NAICS industries to South African three-digit SIC manufacturing industries. In all our estimations we convert the US PPI to rand equivalent using the rand/dollar exchange rate. The rand dollar exchange rate data was downloaded from the South African Reserve Bank. The US total factor productivity (TFP) data was also sourced from the Bureau of Labor Statistics. The data is available at the four-digit NAICS level, we aggregate the data and map it to the South African three–digit SIC classification.

Nominal tariff is measured using average tariff derived from the tariff schedules. The tariff schedules and effective rate of protection data are constructed by Edwards (2005).



### 6.2 Trade Liberalisation in South Africa

Figure 1 shows real sales weighted nominal tariff rate and effective rate of protection over the period 1990-2009, table 1a and 1b shows summary statistics of these variables in levels and percentage change[7] respectively, effective rate of protection values are in parenthesis. Average tariffs fell substantially after 1994, nominal tariffs fell from an average of 15.7% in the period 1990 – 1994 to 5.5% in the period 2005-2009. Most of the tariff cuts were experienced in the periods 1995-1999 and 2000-2004, nominal tariffs fell by 30.5% and 35.3% respectively. In the same periods the standard deviation of nominal tariff has fallen from 9.5% to 3.5%, the decline in standard deviation indicates the decreasing differentials in cross industry tariff levels as tariffs converge to low levels.

Table 2 shows sectoral real sales weighted nominal tariffs and effective rate of protection for the three years: 1990, 2000 and 2009. The three largest declines in nominal tariffs were experienced in: Sawmilling and planning of wood, Basic chemicals, and Basic iron and steel. Dairy products is the only sector which experienced an increase in protection over the period, nominal tariffs in this sector increased by 122% between 1990 and 2009. Despite these sizeable declines, tariffs in some sectors remain relatively high. The three sectors that maintain largest protection levels are Tobacco, Footwear and Dairy products. Their respective tariff levels in 2009 are 18.53, 12.84 and 12.49 percent.

[7] Percentage change in tariffs is calculated as $(TAR_T - TAR_0)/TAR_0$, where T represents the final year of the period and 0 represents the initial year. Percentage change in the effective rate of protection is calculated in the same way.

In addition to substantial cuts in average tariffs, the number of tariff lines fell from 11231 in 1994 to 6420 in 2006. Import surcharges, export subsidies and non-tariff barriers were faced out, Edwards et al (2009).

In addition to nominal tariff rates, we also use effective protection rates to measure trade openness. Effective protection rates have an advantage over tariffs because they account for the cost of raising protection on intermediate inputs, in addition to measuring the total decline in protection levels on final output. Effective rates follow a similar qualitative pattern as nominal tariffs: declining levels and standard deviation, protection rates fell from an average of 51.3% in the period 1990-1994 to 21.3% in the period 2005-2009 and the standard deviation decreased from 74.3 to 22.5 percent. In contrast to nominal tariff, the largest declines in effective rates occurred over the periods 1995-1999 and 2005-2009 with respective values of 75.2 and 42.8 percent. Large declines in ERP, in excess of 100%, were experienced in Beverages, Publishing, and Basic iron and steel. In contrast to tariffs there are more sectors with large increases in ERP. Dairy products, Bodies for motor vehicles, Parts and accessories for motor vehicles, and Grain milling & animal feeds all experienced increases in ERP larger than 100%. Despite the large decline in the average level of ERP, there are sectors that remain highly protected in 2009. Footwear, Knitted fabrics, and Meat fish fruit vegetables oils & fat all have ERP levels above 100% in 2009.



We interpret the fall in average tariffs and effective rates of protection as evidence for trade liberalisation in South Africa. The question of whether South Africa has really liberalised its trade remains unsettled in the literature. Edwards (2006) concludes that “significant progress has been made in simplifying South Africa’s tariff structure and reducing tariff protection, further progress still needs to be made in removing tariff-peaks…” while Fedderke and Vaze (2001) also point out that South Africa has made substantial progress in reducing nominal tariffs, they argue that evidence from effective rates of protection is more ambiguous.

### 6.3 Product Price changes in South Africa

Tariff reductions affect wages through product prices. Therefore, it is important to understand the relationship between tariff reductions and product price changes both at aggregate and sector levels. Figure 2 graphs percentage changes in aggregate tariffs and product prices. On each series we superimpose a smoothered version of the series, this enables us to capture the permanent trend of the series. We use the lowess method of Cleveland (1979) to smooth the series, in doing so we set the bandwidth[8] to 0.8. The percentage change in tariffs series has a negative slope for the most part of the 1990-2009 period, and displays a positive slope in the remaining part. This captures the fact that the rate of fall in tariffs had been increasing in the 1990s, it then levelled off in the early part of the 2000-2009 period and then decreased in the remaining part of the period. The percentage change in product price series is negatively sloping at a constant rate. Figure 2 also reveals that tariff changes are much more volatile than product price changes. The relationship between tariff changes and product price changes, as captured by figure 2, is positive for the most part i.e. 1990-2003/2004, and negative for the remaining part.

Table 3 presents percentage changes in domestic product prices[9] at the sector level over the period 1990-2009, including sub-periods 1990-1999 and 2000-2009. Over the period 1990-2009 73% of the sectors experienced price declines, while over the periods 1990-1999 and 2000-2009, 65% and 63% of the sectors experienced price declines. In the period 1990-2009 the four largest price declines are found in Meat fish vegetable oils & fat (301), Leather and leather products (316), Household appliances (358), and Other transport (384). In the same period the sectors that experienced largest price increases are Petroleum (331), Iron and steel (351), Electric motors (361), and Insulated wire & cables (363).

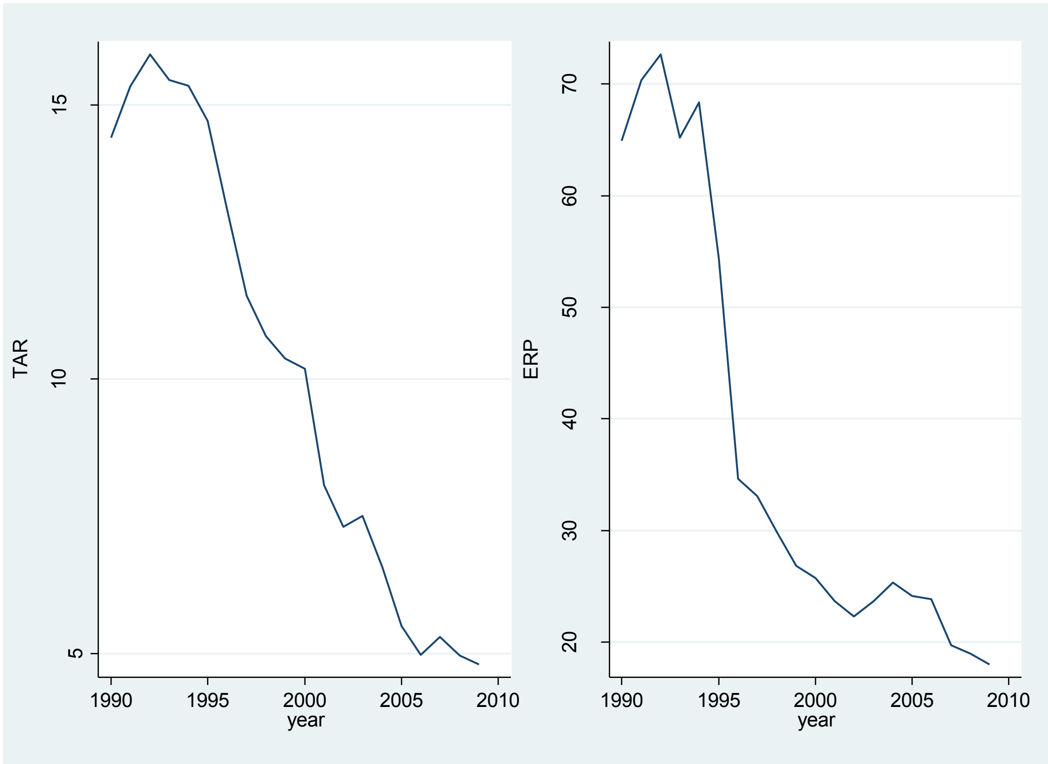
In figure 3, we analyse the relationship between annual price changes and annual tariff changes in the sectors with the largest price changes, these are price changes calculated over the 1990-2009 period. The top part of the table shows the relationship for the sectors with large price declines while the bottom part shows the relation for the sectors with large price increases[10]. In the graphs observations are numbed according to years with a 1 representing a coordinate of price and tariff changes between 1990 and 1991, 2 between 1991 and 1992 etc. Sector 301 experienced its highest price decline of 11% in the year 2000 and its highest tariff decline of 3% in the year 1995. The line of best fit for sector 301 has a positive slope meaning that large tariff declines in this sector are associated with large price declines. A causal interpretation of the graph is that trade liberalisation in this sector has led to a fall in the producer price index. In sectors 316 and 318 the line of best fit is flat meaning that



[8] The bandwidth represents a trade-off between smoothness and goodness of fit, it is a number between 0 and 1. Large values produce smooth curves that may not fit well, and small values lead to curves that fit better but look wiggly.
[9] Price in each sector is defined as PPI in that sector relative to the overall producer price index in the manufacturing sector.
[10] Note that figure 3 we show three sectors instead of four. This is because we do not have tariff data for the sector with the largest price increase (SIC3 code 331) and the sector with the fourth largest price decrease (SIC3 code 371).

there is no relationship between price changes and tariff changes in these sectors. This suggests that the general price decrease which occurred in these sectors were driven by factors other than tariff changes. In the sectors with the largest price increases there is a slightly positive relationship between price changes for sector 351 and 363. On the other hand in sector 361 there is no systematic relationship between tariff changes and price changes.

**Figure 1: SA average tariffs and ERP: 1990 - 2009**




Notes: these are real sales weighted percentage levels of average tariffs (TAR) and effective rate of protection (ERP).

**Table 1a:Summary statistics of level tarrifs and ERP**

| | 1990 - 1994 | | 1995 - 1999 | | 2000 - 2004 | | 2005 - 2009 | |
|---|---|---|---|---|---|---|---|---|
| Mean | 15.7 | (51.3) | 13.5 | (32.6) | 8.8 | (23.7) | 5.5 | (21.3) |
| Std. Dev | 9.5 | (74.3) | 9.2 | (40.5) | 6.20 | (27.7) | 3.5 | (22.5) |
| Minimum | 4.4 | (-11.0) | 0.6 | (-21.0) | 0.4 | (-25.0) | 0.2 | (-4.0) |
| Maximum | 55.06 | (443) | 48.3 | (302.0) | 29.7 | (116.0) | 15.2 | (85.0) |
| Observations | 175 | (175) | 175 | (175) | 175 | (175) | 175 | (175) |

Notes:These are real sales weighted statistics, values describing ERP are in parenthesis. Values are in percentage.

**Table 1b:Summary statistics of percentage changes in tarrifs and ERP**

| | 1990-1994 | | 1995-1999 | | 2000-2004 | | 2005-2009 | |
|---|---|---|---|---|---|---|---|---|
| Mean | 4.7 | (43.5) | - 30.5 | (-75.2) | -35.3 | (-9.8) | -11.8 | (-42.8) |
| Std. Dev | 20.4 | (197.1) | 26.3 | (222.0) | 9.4 | (60.2) | 25.5 | (68.3) |
| Minimum | -25.2 | (-95.7) | -82.1 | (-1150) | -60.0 | (-300) | -61.3 | (-300) |
| Maximum | 127.9 | (1000) | 31.4 | (192) | -11.67 | (118.5) | 67.0 | (80.0) |
| Observations | 175 | (175) | 175 | (175) | 175 | (175) | 175 | (175) |

Notes:These are real sales weighted statistics, values describing ERP are in parenthesis. Values are in percentage. Percentage change is calculated as $(TAR_T – TAR_0)/TAR_0$, where 0 and T are initial and final years of the period.

**Table 2: Level and percentage change in tariffs and effective rate of protection by sector**

| | 1990 | | 2000 | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| Product name | TAR | ERP | TAR | ERP | TAR | ERP | PΔTAR | PΔERP |
| Meat, fish, fruit, vegetables, oils & fat [301] | 13.3 | 50.6 | 12.8 | 26.9 | 7.6 | 64.0 | -43.3 | 26.5 |
| Dairy products [302] | 5.6 | 5.6 | 28.7 | 89.3 | 12.5 | 35.7 | 122.6 | 542.6 |
| Grain milling & animal feeds [303] | 6.8 | -1.0 | 7.4 | -25.3 | 3.6 | -3.9 | -47.1 | 312.1 |
| Other food products [304] | 14.4 | 49.5 | 15.1 | 24.2 | 6.5 | 21.8 | -54.9 | -56.0 |
| Beverages [305] | 14.7 | 16.4 | 14.0 | 2.6 | 7.2 | -0.5 | -51.3 | -102.9 |
| Tobacco [306] | 24.5 | | 32.0 | | 18.5 | | -24.5 | |
| Spinning and weaving [311] | 19.8 | 64.5 | 24.4 | 57.6 | 7.9 | 40.1 | -60.0 | -37.9 |
| Other textiles [312] | 21.5 | 24.9 | 21.5 | 18.8 | 9.7 | 11.1 | -54.9 | -55.3 |
| Knitted fabrics [313] | 21.2 | 84.4 | 29.7 | 109.3 | 10.5 | 69.3 | -50.6 | -17.9 |
| Leather and leather products [316] | 15.5 | 47.3 | 13.1 | 14.4 | 6.1 | 15.3 | -60.3 | -67.7 |
| Footwear [317] | 26.4 | 71.1 | 23.3 | 68.5 | 12.8 | 63.5 | -51.3 | -10.7 |
| Sawmilling and planning of wood [321] | 6.0 | 4.3 | 0.6 | -3.7 | 0.2 | 5.3 | -96.6 | 22.8 |
| Wood and wood products [322] | 13.8 | 4.3 | 11.4 | -3.7 | 5.5 | 5.3 | -60.0 | 22.8 |
| Paper and paper products [323] | 8.6 | 6.6 | 6.8 | 12.5 | 1.9 | 2.8 | -77.4 | -58.1 |
| Publishing [324] | 10.5 | 35.2 | 3.3 | -4.7 | 2.0 | -2.5 | -80.7 | -107.2 |
| Basic chemicals [334] | 9.2 | 8.2 | 1.5 | 2.5 | 0.7 | 3.6 | -92.7 | -56.1 |
| Rubber products [337] | 17.6 | 61.5 | 12.7 | 43.7 | 5.7 | 31.2 | -67.5 | -49.2 |
| Plastic products [338] | 19.0 | 53.0 | 10.1 | 23.1 | 4.9 | 18.5 | -74.2 | -65.0 |
| Glass and glass products [341] | 12.2 | 41.8 | 7.5 | 13.3 | 2.7 | 11.9 | -77.6 | -71.5 |
| Non-metallic mineral products | 12.1 | 27.7 | 5.4 | 10.2 | 3.0 | 9.5 | -75.1 | -65.6 |
| Basic iron and steel [351] | 8.3 | 25.3 | 4.5 | 8.9 | 0.6 | -0.7 | -93.0 | -102.7 |
| Non-ferrous metals [352] | 9.2 | 18.8 | 2.5 | 1.8 | 1.0 | 0.6 | -89.4 | -96.9 |
| Structural steel products [354] | 9.4 | 30.8 | 4.5 | 12.0 | 2.5 | 11.9 | -73.7 | -61.3 |
| Other fabricated metal products [355] | 14.3 | 47.3 | 8.5 | 13.8 | 4.9 | 15.4 | -65.9 | -67.4 |
| Special purpose machinery [357] | 5.0 | -5.9 | 2.1 | -5.5 | 1.8 | -3.5 | -64.9 | -40.0 |
| Household appliances [358] | 16.3 | 83.1 | 12.9 | 31.6 | 6.5 | 32.6 | -60.0 | -60.7 |
| Electrical motors, and transformers [361] | 13.6 | 10.2 | 7.8 | 5.1 | 3.8 | 9.2 | -72.3 | -9.8 |
| Electricity dbn and control apparatus [362] | 13.2 | 18.7 | 7.9 | 7.8 | 3.6 | 3.5 | -72.3 | -81.2 |
| Insulated wire and cable [363] | 14.6 | 57.2 | 13.5 | 39.0 | 7.3 | 19.2 | -50.2 | -66.4 |
| Accumulators and batteries [364] | 17.5 | 69.4 | 7.7 | 4.7 | 2.7 | 2.6 | -84.8 | -96.3 |
| Electric lamps and lighting equipment [365] | 16.2 | 68.3 | 11.1 | 35.6 | 5.0 | 27.4 | -69.0 | -60.0 |
| Other electrical equipment [366] | 10.1 | 31.2 | 2.7 | -0.8 | 1.6 | 1.0 | -84.3 | -96.7 |
| Motor vehicles [381] | 36.1 | 398.0 | 19.2 | 116.0 | 8.3 | 48.7 | -77.0 | -87.8 |
| Bodies for motor vehicles [382] | 16.7 | 22.2 | 16.3 | 67.6 | 8.4 | 46.0 | -49.4 | 106.9 |
| Parts and accessories for motor vehicles [383] | 12.6 | 22.2 | 15.4 | 67.6 | 9.1 | 46.0 | -28.2 | 106.9 |
| Furniture [391] | 22.4 | 85.8 | 18.3 | 48.2 | 10.0 | 38.6 | -55.3 | -55.1 |
| Other manufacturing [392] | 19.5 | 87.7 | 7.6 | 4.9 | 4.0 | 5.4 | -79.5 | -93.9 |

Notes: These are real sales weighted variables. The last two columns tabulate percentage changes in tariffs (PΔTAR) and effective rate of protection (PΔERP) over the period 1990 - 2009. There is no ERP data on Tobacco products.

**Figure 2: Percentage change in average tariffs and product price index**


Notes: These are real sales weighted percentage changes in product prices (PPI) and tariffs (TAR). A smoothered version of each series is superimposed on the series to capture the permanent trend of the series.

## Table 3: Percentage change in domestic product prices

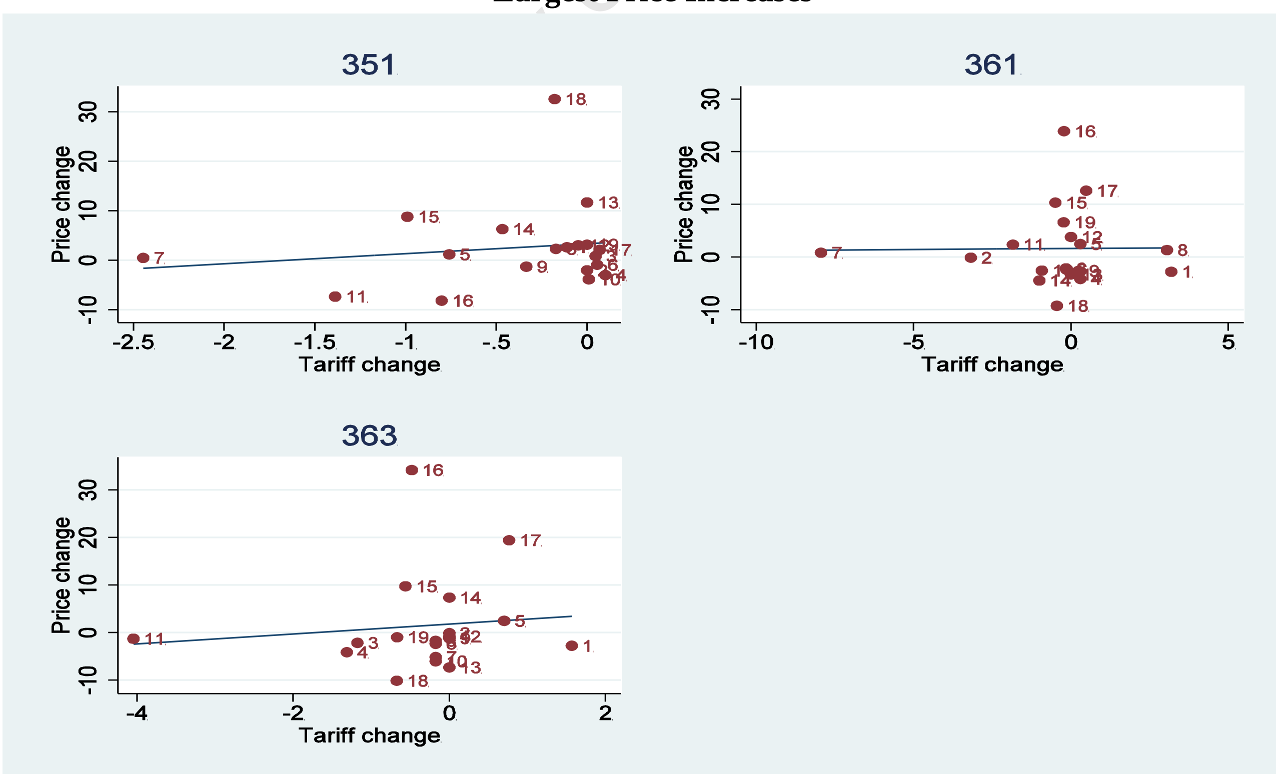
| Product name | 1990 - 1999 | 2000 - 2009 | 1990 - 2009 |
|---|---|---|---|
| Meat, fish ,fruit, vegetables, oils & fat [301] | 4.1 | -44.0 | -44.6 |
| Dairy products [302] | -2.5 | 12.2 | 7.0 |
| Grain mill & animal feeds [303] | 4.0 | 0.6 | 1.6 |
| Other food products [304] | 9.9 | 12.7 | 21.7 |
| Beverages and tobacco products [305] | 18.9 | 2.5 | 20.0 |
| Spinning and weaving [311] | -13.9 | -17.4 | -32.7 |
| Other textile products [312] | -15.5 | -22.9 | -37.1 |
| Knitting mill products [313] | -10.0 | -27.1 | -38.2 |
| Wearing apparel [314] | -8.6 | -30.1 | -36.9 |
| Leather & leather products [316] | -1.2 | -39.0 | -41.1 |
| Footwear [317] | 5.1 | -18.7 | -18.7 |
| Wood products [322] | -15.6 | 6.2 | -13.0 |
| Paper and paper products [323] | 8.3 | -13.7 | -6.2 |
| Published and printed products [324] | 19.5 | 3.3 | 22.2 |
| Petroleum products [331] | 8.4 | 16.0 | 74.0 |
| Basic chemical products [334] | -5.4 | -6.1 | -11.5 |
| Other chemical products [335] | -5.6 | -5.3 | -9.0 |
| Rubber products [337] | -5.7 | 22.0 | 14.5 |
| Plastic products [338] | -9.5 | -8.3 | -17.5 |
| Glass and glass products [341] | -17.8 | -10.8 | -29.1 |
| Non-metallic mineral products [342] | 6.3 | 18.2 | 24.9 |
| Iron and steel products [351] | 0.2 | 68.3 | 62.3 |
| Non-ferrous metals [352] | -24.1 | -14.8 | -32.2 |
| Structural metal products [354] | -3.0 | 5.5 | -2.8 |
| Other fabricated metal products [355] | -8.2 | 4.7 | -8.7 |
| General machinery [356] | -11.1 | -6.6 | -20.6 |
| Special machinery [357] | -12.9 | -16.8 | -30.3 |
| Household appliances [358] | -16.9 | -25.3 | -40.8 |
| Electric motors [361] | -9.1 | 53.1 | 35.6 |
| Electricity apparatus [362] | -3.0 | -15.5 | -21.7 |
| Insulated wire and cable [363] | -15.8 | 64.9 | 30.8 |
| Accumulators [364] | -9.9 | 24.7 | 6.6 |
| Lighting equipment [365] | -7.3 | 10.1 | -1.7 |
| Other electrical products [366] | -1.4 | -19.2 | -20.6 |
| Radio and television products [371] | -14.8 | -27.5 | -40.0 |
| Optical instruments [374] | 31.9 | -18.9 | 2.5 |
| Motor vehicles [381] | 11.0 | -21.8 | -14.1 |
| Motor vehicles parts [383] | 9.3 | -20.1 | -14.9 |
| Other transport products [384] | -25.2 | -35.0 | -54.5 |
| Furniture [391] | 7.5 | -20.1 | -18.3 |
| Other manufacturing [392] | -11.1 | -25.7 | -36.8 |

Notes: These are percentage changes in domestic product prices (PPI). Percentage change is calculated as $(TAR_T - TAR_0)/TAR_0$, where 0 and T are initial and final years of the period. Price in each sector is defined as PPI in that sector relative to the overall manufucturing price index.

**Figure 3: Log Price and Tariff Changes**

**Largest Price Decreases**


**Largest Price Increases**



## 7. Results

### 7.1 The Sector Bias of Tariff Changes

Figures 3a-3c show scatter plots of industry tariff changes against skill intensity[11] together with the line of best fit for the three periods. A positively sloped line indicates that level cuts in tariffs are concentrated in unskill-intensive sectors while a negative slope would indicate that tariff reduction are concentrated in skilled-intensive sectors. Figure 3a reveals that over the entire period 1999-2009 tariff reductions were concentrated in unskill-intensive sectors. Figure 3b and 3c provide more insight about the sector bias of tariff changes over the period 1990-2009. Together they reveal that the sector bias of tariff reductions did not remain constant over the period. Skill-intensive sectors experienced larger tariff cuts between 1990 and 1999 while unskill-intensive sectors experienced larger cuts in the other half of the period.

Table 4 presents results for the regression of tariff changes on factor cost shares (equation 6) for the three periods. A larger coefficient on the skilled labor share than the unskilled labor share means that tariff reductions were concentrated in unskill-intensive sectors. The message from table 3 is the same as that in figures 3a-3c: tariff cuts were concentrated in unskill-intensive sectors in the period 1990-2009 and 2000-2009, and concentrated in skill-intensive sectors in the period 1990-1999. If we assume a uniform pass-through coefficient from tariff changes to product prices then the sector bias of tariff reductions provides consistency checks for mandated changes in wage inequality. So for our estimates to be consistent with this sector bias of tariff changes, they should reveal a mandated rise in the skill premium for the period 1990-2009 and 2000-2009, and a mandated fall for the period 1990-1999.



[11] We define skill-intensity as the ratio of skilled to unskilled labor cost shares.

**Figure 3a: Sector bias of tariffs changes 1990 – 2009**

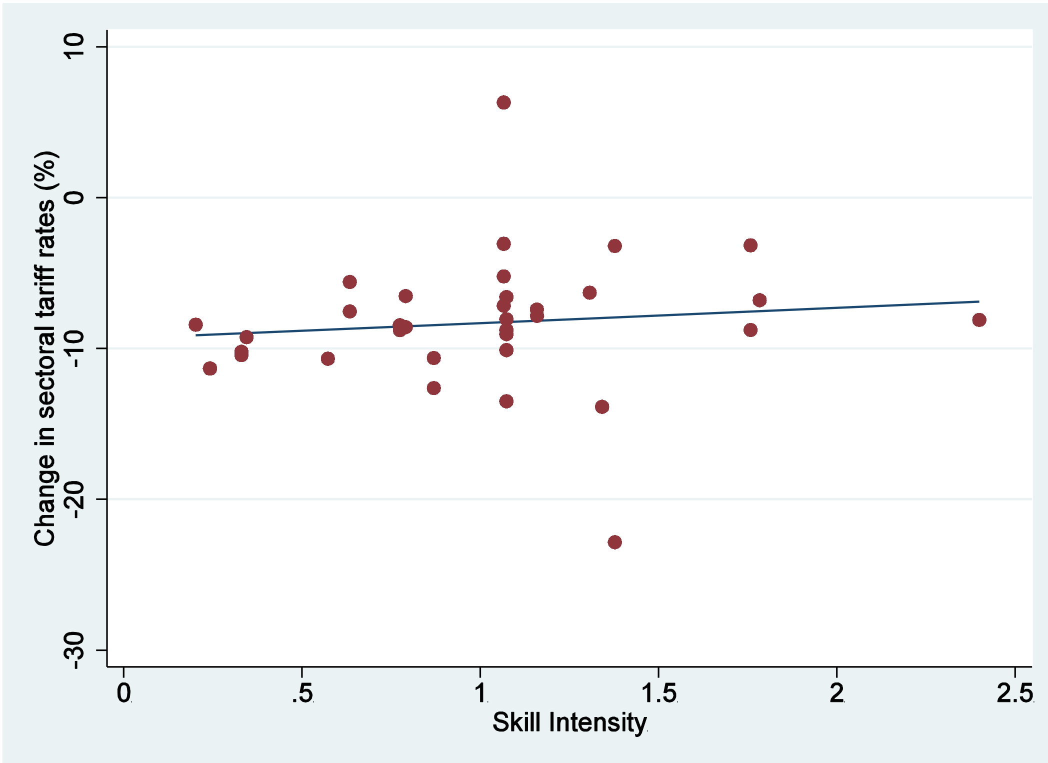



**Figure 3b: Sector bias of tariff changes 1990 - 1999**

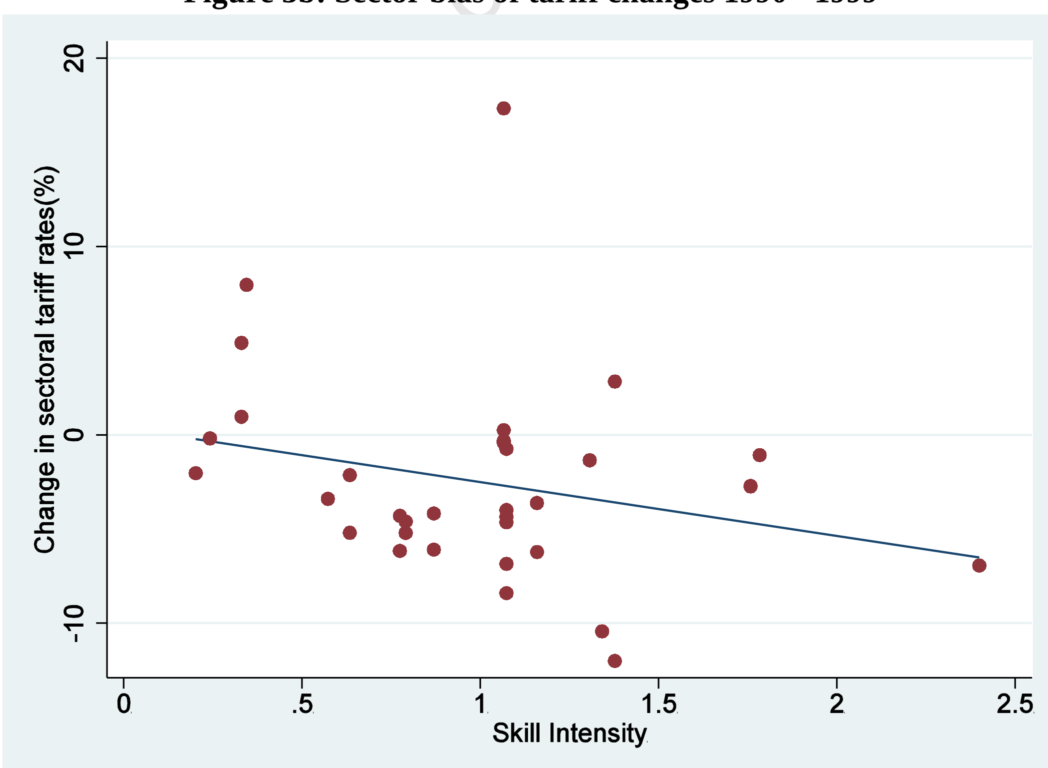
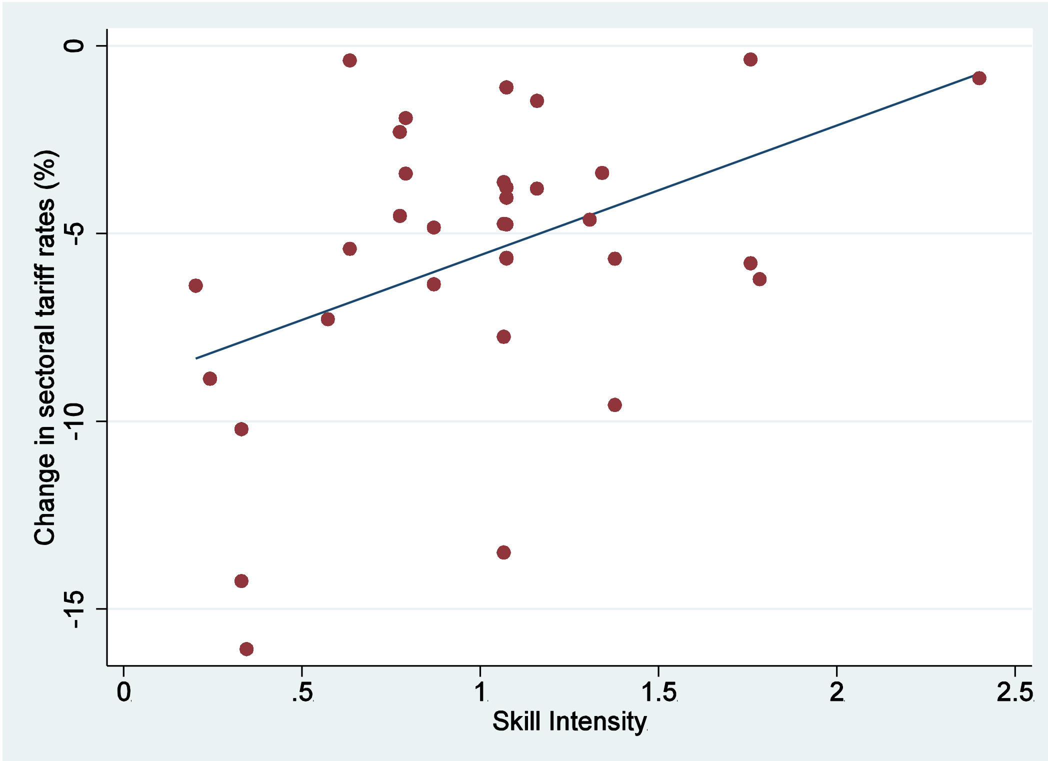


**Figure 3c: Sector bias of tariff changes 2000 - 2009**




Notes: Each of figure 2a – 2c contains the line of best fit of barrier changes on industry skill intensity, where industry skill intensity is the ratio of skilled to unskilled labor cost shares. Observations are weighted by real sales. SIC 324 was omitted because it has a very high skill intensity (5.112).



**Table 4: Sector bias of tariff changes**
**Dependant variable: $\triangle \ln (1 + TAR_{nt})$**

| | 1990 - 2009 | | 1990 - 1999 | | 2000 - 2009 | |
|---|---|---|---|---|---|---|
| $V_s$ | -0.037 | (-0.90) | -0.402 | (-8.39) | 0.368 | (10.32) |
| $V_u$ | -0.147 | (-4.26) | 0.105 | (2.40) | -0.219 | (-6.64) |
| $V_k$ | -0.140 | (-6.76) | -0.192 | (-7.56) | 0.059 | (3.29) |
| $V_I$ | -0.073 | (-7.02) | 0.029 | (2.25) | -0.105 | (-15.07) |
| $V_s$ - $V_u$ | 0.11 | (1.73) | -0.504 | (7.24) | 0.587 | (10.09) |
| Observations | 700 | | 350 | | 350 | |

Notes: cell entries are parameter estimates (and t-statistics for robust standard errors) for estimates of equation (6). The sixth row of each column reports results for the test of whether the coefficients on unskilled and skilled labour cost shares are equal. For each period sectoral tariff changes are calculated as: $\Delta\ln(1+TAR_{i0}/1+TAR_{iT})$, where 0 and T are initial and final years of the period.

### 7.2 Prices and Mandated Factor Returns

Table 5 presents results for the estimation of the first-stage regression (4.2). Each column in the table corresponds to the similarly numbered specification of the first-stage regression. All variables are logarithmic [12] changes except capital labor-ratio. Cell entries are parameter estimates and heteroskedastic-robust t-statistics in parenthesis. Cluster-robust standard errors are estimated to account for intra-industry correlations. All estimations include three digit industry fixed effects, observations are weighted by real sales. The term $BP^*$ is a matrix of weighted product price changes. Each row in this matrix corresponds to the second term on the right of equation 4.2.

Looking at the first specification (4.2a) we see that the tariff coefficient is significant and correctly signed. A 10% reduction in (1+TAR) reduce domestic prices by 2%. Tariff changes remain significant and positive even after controlling for international technology and world price changes (4.2b). International technological change as proxied by US-TFP is revealed to not have a significant effect on domestic prices. World price as proxied by US-PPI is correctly signed but not statisticaly significant at standard levels. Controlling for market structure (4.2c) does not change the statistical significance and sign on the  tariff coefficient. The coefficient on the interaction of capital-labor ratio with tariff changes in not significant, this suggest that the pass-through rate from tariffs to product prices does not depend on market structure.

Table 6 presents results for the second-stage regression. Each column corresponds to a similarly numbered column in table 5, we focus on the results corresponding to specification 4.2b as the coefficient on tariff does not change much across specifications. Each sub-table gives results for a given period. For each period, sectoral tariff changes are calculated as logarithmic changes over the period: $\Delta \ln(1+TAR_{i0}/1+TAR_{iT})$, where 0 and T are initial and final years of the period.

In the period 1990-2009, tariff reductions mandated a fall in factor returns across all specifications of equation 4.2. Looking at the second column, we see that returns to capital decreased by 2.9% while returns to skilled and unskilled labor fell by 0.8% and 3.1% respectively. This translates into a rise in the skill premium[13] of 3.3%, which is significant at 10%. All other columns are interpreted in the

[12] Because this is a log-log model coefficients are interpreted as elasticities.
[13] The sixth row of each sub-table gives results for the test of whether the skill premium ($V_s$ - $V_u$) has significantly changed over the period.

same way. The remaining sub-tables present results for the periods: 1990-1999 and 2000-2009. This separation of the entire period allows us to examine whether the skill premium exhibit constant behavior within the period or not. In the period 1990-1999, trade liberalisation mandated a fall in skilled labor returns and a rise in unskilled labor returns of 8.4% and 2.2% respectively. This implies a mandated fall in wage inequality of 10.6%, which highly significant. Capital experienced a decline in mandated returns of 4.0% during this period. Over the period 2000-2009, returns to capital rose by 1.2% because of tariff reductions. In the same period trade liberalisation mandated a 11.6% rise in the skill premium, the breakdown of this is 7.7% increase in skilled labor returns and 4.6% decrease in unskilled labor returns.

In all periods, the mandated change in the skill premium is qualitatively the same as that implied by the suggestive evidence from the sector bias of tariff changes. Two studies that have estimated wage effects of trade openness both find mandated decline the skill premium. These studies have looked at the times 1972-1997 (Fedderke et al. 2003) and 1994-2003 (Edwards and Behar 2005). These periods intersect with the first half of our two periods: 1990-1999. We also find a mandated fall in wage inequality over this period. Therefore, in this sense our results tell the same story as these two studies. We find a mandated rise in the skill premium over the whole period 1990-2009 because the second period 2000-2009 effect dominates the first period.

**Table 5: First stage - price equation**
**Dependant Variable: $\Delta lnP_{it}$**

| | 4.2a | | 4.2b | | 4.2c | |
|---|---|---|---|---|---|---|
| $\Delta ln(1+TAR_{it})$ | 0.197 | (2.17) | 0.208 | (2.23) | 0.351 | (2.22) |
| $BP^*$ | 0.673 | (4.95) | 0.662 | (4.93) | 0.664 | (4.93) |
| $\Delta lnTFP_{it}$ | | | 0.062 | (0.41) | 0.062 | (0.41) |
| $\Delta lnUSPPI_{it}$ | | | 0.018 | (0.49) | 0.018 | (0.49) |
| $\Delta ln(1+TAR_{it}) \times (K/L)_{it}$ | | | | | -0.006 | (-1.47) |
| Observations | 646 | | 646 | | 625 | |

Notes: cell entries are parameter estimates (and heteroskedastic-robust t-statistics) for estimates of equations 4.2a to 4.2c. Cluster-robust standard errors are estimated to account for intra-industry correlations. All estimations use real sales weights.

**Table 6: Second stage – Mandated factor returns**
**Dependant variable: $\hat{\delta_1} \triangle \ln\left(1 + TAR_{nt}\right)$**

**1990-2009**

| | 4.2a | | 4.2b | | 4.2c | |
|---|---|---|---|---|---|---|
| $V_s$ | -0.007 | (-0.90) | -0.008 | (-0.90) | -0.013 | (-0.90) |
| $V_u$ | -0.029 | (-4.26) | -0.031 | (-4.26) | -0.052 | (-4.26) |
| $V_k$ | -0.028 | (-6.78) | -0.291 | (-6.78) | -0.049 | (-6.78) |
| $V_I$ | -0.014 | (-7.03) | -0.015 | (-7.03) | -0.026 | (-7.03) |
| $V_s$ - $V_u$ | 2.2p | (1.73) | 3.3p | (1.73) | 3.9p | (1.73) |
| Observations | 700 | | 700 | | 700 | |

**1990-1999**

| | 4.2a | | 4.2b | | 4.2c | |
|---|---|---|---|---|---|---|
| $V_s$ | -0.079 | (-8.45) | -0.084 | (-8.45) | -0.141 | (-8.45) |
| $V_u$ | 0.021 | (2.42) | 0.022 | (2.42) | 0.037 | (2.42) |
| $V_k$ | -0.038 | (-7.60) | -0.040 | (-7.60) | -0.068 | (-7.60) |
| $V_I$ | 0.006 | (2.26) | 0.006 | (2.26) | 0.010 | (2.26) |
| $V_s$ - $V_u$ | -9.98p | (7.29) | -10.6p | (7.29) | -17.8p | (7.29) |
| Observations | 350 | | 350 | | 350 | |

**2000-2009**

| | 4.2a | | 4.2b | | 4.2c | |
|---|---|---|---|---|---|---|
| $V_s$ | 0.073 | (10.42) | 0.077 | (10.42) | 0.129 | (10.42) |
| $V_u$ | -0.043 | (-6.69) | -0.046 | (-6.69) | -0.077 | (-6.69) |
| $V_k$ | 0.012 | (3.32) | 0.012 | (3.32) | 0.021 | (3.32) |
| $V_I$ | -0.021 | (-15.14) | -0.022 | (-15.14) | -0.037 | (-15.14) |
| $V_s$ - $V_u$ | 11.6p | (10.19) | 11.6p | (10.19) | 20.6p | (10.19) |
| Observations | 350 | | 350 | | 350 | |

Notes: Cell entries are parameter estimates and (robust t-statistics) for estimates of equation 5. Each column here corresponds to the similarly numbered column in one of the first-stage regressions in table 4. The sixth row of each sub-table gives results for the test of whether the skill premium ($V_s$ - $V_u$) has significantly changed in each period, "p" stands for percent. For each period sectoral tariff changes are calculated as: $\Delta\ln(1+TAR_{i0}/1+TAR_{iT})$, where 0 and T are initial and final years of the period.

## 8. Robustness

In this section we test the robustness of our results by changing the first stage regression in four ways. First, we keep the specification in 4.2b but use effective rates of protection as a measure of trade liberalisation instead of tariffs, we use level changes instead of logarithmic changes because the effective rates of protection series contains negative observations. The first stage results are presented in table 7.1 and the corresponding second stage results are presented in the column numbered “1” in table 8. The effective rate of protection coefficient is positive but not statistically significant. Technology and world price coefficients still do not have a significant effect on domestic product prices. In the second stage equation we still find a mandated fall in the skill premium for the period 1990-1999. In contrast to the estimation of 4.2b with tariffs, we find a statistically insignificant fall in the skill premium over the period 2000-2009. Over the entire period 1990-2009 we find a mandated fall in the skill premium, this is also different to the rise we found when we used nominal tariffs as a measure of trade openness. Therefore our results are sensitive to how trade liberalisation is measured.

Second, we keep the specification in 4.2b, still we use tariffs to measure openness, but introduce time fixed effects. The first-stage regression results are shown in the column numbered “2” in table 7.2 and the second stage results are presented in the similarly numbered column in table 8. The tariff coefficient is still correctly signed but insignificant. The coefficient on US price is now significant and correctly signed. A 10% increase in the US price leads to a 3.4% increase in the domestic price. The second stage results are qualitatively similar: a fall in the skill premium over the period 1990-1999, and a rise in the skill premium in the periods 2000-2009 and 1990-1999. The mandated changes in the skill premium are smaller in magnitude when compared to the estimation of 4.2b without time fixed effects. We find a 1% rise in the period 1990-2009, 4.4% fall in the period 1990-1999 and a 5.1% mandated rise in the skill premium over the period 2000-2009. This suggests that time effects do not drive our results.

Third, we keep the specification in 4.2b, still we use tariff changes to measure openness, but we do not weight observations. The column numbered “3” in table 7.2 shows the first stage results and the similarly numbered column in table 8 shows second stage results. Tariff changes remain positive and significant, and both technology and the US price are still positive and insignificant. Therefore, the unweighted first stage results are similar to the weighted. The mandated rise in the skill premium for the period 1990-2009 is 3.7% which is close to the 3.3% in the weighted regression. The mandated change in the skill premium for the subperiods 1990-1999 and 2000-2009 from the unweighted regressions is also similar to that of weighted regressions. Therefore, weighted results and unweighted results are very similar.

Fourth, we estimate the first-stage regression from equation 4.1 instead of 4.2. In Equation 4.1 the regressand is the value added price series instead of final product price series. We include changes in tariffs, technology and US price as structural regressors. We also include SIC three digit fixed effects. The results are shown in the column numbered “4” in table 7.2. None of the coefficients is significant, and the US price has an unexpected sign. Therefore, our results are not robust to the use of value added price as a dependent variable instead of final product price.

**Table 7.1: First stage - price equation with ERP**
**Dependant variable: $\Delta P_{it}$**

| | 1 | |
|---|---|---|
| $\Delta ERP_{it}$ | 0.054 | (0.13) |
| $BP^{*}$ | 88.28 | (2.27) |
| $\Delta TFP_{it}$ | 0.067 | (0.35) |
| $\Delta USPPI_{it}$ | 0.005 | (1.11) |
| Observations | 646 | |

Notes: cell entries are parameter estimates (and heteroskedastic-robust t-statistics) for estimates of equations 4.2b. We use level changes instead of logarithmic changes because the effective rate of protection series contains negative observations. Cluster-robust standard errors are estimated to account for intra-industry correlations. All estimations use real sales weights.

**Table 7.2: First stage - price equation**
**Dependant variable: $\Delta \ln P_{it} / \Delta \ln P^{v}_{it}$**

| | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|
| $\Delta \ln (1+TAR_{it})$ | 0.086 | (1.16) | 0.199 | (3.33) | 0.009 | (0.05) |
| $BP^{*}$ | 0.796 | (4.62) | 0.647 | (6.56) | | |
| $\Delta \ln TFP_{it}$ | -0.067 | (-0.54) | 0.064 | (0.58) | 0.087 | (0.56) |
| $\Delta \ln USPPI_{it}$ | 0.343 | (5.75) | 0.037 | (1.39) | -0.045 | (-1.39) |
| Observations | 646 | | 646 | | 646 | |

Notes: cell entries are parameter estimates (and heteroskedastic-robust t-statistics) for estimates of regression 4.2b and 4.1. Cluster-robust standard errors are estimated to account for intra-industry correlations. The columns numbered "2" and "3" use final product prices ($\Delta \ln P_{it}$) as the dependant variable and the column numbered "4" uses value added prices as the dependant variable ($\Delta \ln P^{v}_{it}$).

**Table 8: Second stage – Mandated factor returns**
**Dependant variable: $\hat{\delta_1} \triangle \ln \mathrm{ERP_{nt}} / \hat{\delta_1} \triangle \ln(1 + \mathrm{TAR_{nt}})$**

**1990-2009**

| | 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|
| $V_s$ | -0.202 | (-4.03) | -0.003 | (-0.90) | -0.019 | (-3.84) |
| $V_u$ | 0.046 | (1.79) | -0.013 | (-4.26) | -0.056 | (-10.6) |
| $V_k$ | -0.059 | (-4.71) | -0.012 | (-6.78) | -0.035 | (-9.65) |
| $V_I$ | | | -0.006 | (-7.03) | -0.006 | (-3.20) |
| $V_s$ - $V_u$ | -0.248 | (3.36) | 1.0p | (1.73) | 3.7p | (6.75) |
| Observations | 700 | | 700 | | 700 | |

**1990-1999**

| | 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|
| $V_s$ | -1.81 | (-3.08) | -0.035 | (-8.45) | -0.097 | (-10.85) |
| $V_u$ | 0.039 | (1.32) | -0.009 | (2.42) | 0.022 | (2.14) |
| $V_k$ | -0.038 | (-2.51) | -0.017 | (-7.60) | -0.058 | (-9.25) |
| $V_I$ | | | 0.002 | (2.26) | 0.014 | (3.97) |
| $V_s$ - $V_u$ | -1.85 | (2.56) | -4.4p | (7.29) | -11.9p | (10.06) |
| Observations | 350 | | 350 | | 350 | |

**2000-2009**

| | 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|
| $V_s$ | -0.029 | (-2.05) | 0.032 | (10.42) | 0.076 | (11.08) |
| $V_u$ | 0.004 | (0.50) | -0.019 | (-6.69) | -0.063 | (-8.70) |
| $V_k$ | -0.012 | (-3.11) | -0.005 | (3.32) | 0.025 | (7.37) |
| $V_I$ | | | -0.009 | (-15.14) | -0.022 | (-13.76) |
| $V_s$ - $V_u$ | 0.033 | (1.53) | 5.1p | (10.19) | 13.9p | (12.30) |
| Observations | 350 | | 350 | | 350 | |

Notes: Cell entries are parameter estimates and (robust t-statistics) for estimates of equation 5. Each column here corresponds to the similarly numbered column the first-stage regressions in tables 6.1 and 6.2. The sixth row of each sub-table (the one with ($V_s$ - $V_u$) gives results for the test of whether the skill premium has significantly changed in each period, "p" stands for percent. For each period sectoral tariff changes are calculated as: $\Delta\ln(1+TAR_{i0}/1+TAR_{iT})$, where 0 and T are initial and final years of the period. In the columns numbered "1" ("2") we use ERP (TAR) to construct the dependant variable.

## 9. Conclusion

Our goal in this paper was to quantify the effect of trade liberalisation on the skill premium in the South African manufacturing industry. We adopt the mandated wage framework in which trade barrier changes affect the skill premium through product prices. We find that over the periods 1990-2009 and 2000-2009 tariffs cuts were concentrated in unskill-intensive sectors suggesting a rise in the skill premium, while over the period 1990-1999 tariff cuts were concentrated in skill-intensive sectors suggesting a fall in the skill premium. The reduction in tariff cuts lead to a decline in product prices. This tariff induced reduction in product prices mandated changes in the skill premium that are consistent with the sector bias of tariffs cuts. In the period 1990-2009 we find a mandated rise in the skill premium of 3.3%. The change in the skill premium does not remain constant throughout the period. In the sub-period 1990-1999 we find a mandated fall in the skill premium of 10.6%, while in the sub-period 2000-2009 tariffs cuts working through product prices mandated a rise in the skill premium of 11.6%.

Our main results are robust to time effects and the weighting of industries. However, they are not robust to the measurement of trade liberalisation. They are also not robust to the use of value added prices as a dependent variable, in the first stage equation, instead of final product prices.

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